THURSDAY, JANUARY 10, 1901.

THE SCIENCE OF ORE DEPOSITS.

Lehre von den Erzlagerstätten. By Dr. R. Beck. 1 Theil. Pp. iv + 384. (Berlin: Borntraeger, 1901.)

IN striking contrast to the almost universal neglect with which the subject of ore deposits is treated in this country is the increasing attention that it is receiving from geologists and mining engineers abroad, and more especially in Germany and in the United States. In the recently published annual general report and statistics of the output of minerals in Great Britain, by Dr. C. Le Neve Foster, attention is called to the fact that our production of all metalliferous minerals, already small, is continually shrinking, and whilst this unpleasant fact may be the cause of the above-noted neglect of the study of ore deposits, it may equally well be an effect thereof, and may present one more example of the way in which we are being left behind by other nations in industrial pursuits, merely because we so uniformly disdain to study their scientific aspects.

The work now under review serves well to emphasise the difference between the treatment of scientific technology in the two countries; it is written by the professor of geology and of the science of mineral deposits at the ancient and famous Royal Mining School of Freiberg. In this country we have no ancient mining schools—perhaps even no mining schools at all, as the Germans understand this term—and not a single professorship devoted to the study of mineral deposits.

This latter subject has nowhere been the subject of more assiduous study than it has at Freiberg, and this fact alone would make the present treatise one of exceptional importance. Its author is, moreover, a recognised authority on the theory of ore deposits, and his work is marked with decided originality in many respects. The only difficulty in forming a fair estimate of it lies in the fact that the volume before us is only half a book, concluding abruptly in the middle of a chapter. It seems that the remainder is not to be published till next year, and as the present part does not include any table of contents it is impossible to say now what the scope of the completed work will be. It is hard to see what good end is to be served by this fragmental system of publication.

The most interesting point about any work on ore deposits is the system of classification and arrangement adopted in it. Dr. Beck commences his work by a division of all deposits into two main groups, (1) Primary, and (2) Secondary, the latter group including the deposits formed by the destruction of pre-existing ones, whether as alluvial deposits or by disintegration *in situ*. It is obvious that such a division is defective in many respects, apart from the fact that the two groups thus formed are of very unequal importance. In the first place it is impossible in many cases to predicate with certainty of an ancient deposit that it was primary in its origin, seeing that all traces of its original genesis may have been lost owing to wide-reaching metamorphism; and, again, there is no real genetic difference between a recent mineral deposit and an ancient one, and it is illogical to base the first great classificatory grouping upon a distinction of such little real importance. Worst of all, the author finds himself unable to maintain his own classificatory system. A striking example of this defect is his inclusion amongst the primary deposits of "bedded gold deposits of Palæozoic and Mesozoic age," the first example of which, given by him, is certainly an alluvial deposit of Cambrian age, whilst all the others were probably also alluvial deposits. Dr. Beck's inclusion of Tertiary and more recent alluvial deposits in his secondary group, whilst all alluvials older than Tertiary are included among primary deposits, is as arbitrary as it is unpractical, and, moreover, is in no way justified by his own definitions.

The group of primary deposits is here further divided into (*a*) *Syngenetic*, or such as were formed contemporaneously with the surrounding rocks, and (*b*) *Epigenetic*, or such as were formed subsequently; the first class is again subdivided into (1) Magmatic segregations, and (2) Stratified ore deposits, and the second class into (1) Fissure veins, and (2) Deposits that are not vein-like; the latter class is again further subdivided, but the deposits included in it are not covered by the present volume, so that their discussion must be deferred. Perhaps the least satisfactory group of the present classification is the first subclass of magmatic segregations, which is intended to cover ore deposits produced by magmatic differentiation from molten eruptive rocks. We doubt whether many geologists would even endorse fully the opening sentence of this section: "The origin of metals is, without doubt, the inaccessible interior of the earth's crust," more especially seeing that the main argument in support of this very dogmatic statement is based upon the high specific gravity of the earth as a whole, compared with that of the rocks composing its surface. This subclass is divided into three sections, namely, segregations of native metals, of oxidised ores and of sulphuretted ores respectively. The first section is especially unfortunate; the first examples quoted, namely, native iron in the island of Disko, nickeliferous iron at Awarua, New Zealand, and platinum in the Urals, are none of them mineral deposits in the sense in which Dr. Beck, quite correctly, defines the word, namely, deposits of mineral of economic importance; further, the last example, namely, the occurrence of native copper in the melaphyres of Lake Superior, is certainly not a case of magmatic segregation, but is a well-marked instance of an epigenetic deposit; and the only other example, that of the occurrence of gold in certain eruptive rocks, is in many cases neither of economic importance nor of indisputably magmatic origin. The next section, that of the oxidised ores, is more satisfactory in many respects, although doubts may well be entertained of the soundness of any system of classification that separates, as widely as Dr. Beck does, the iron ore deposits of Kirunavaara and Luossavaara from those of Gellivaara and Svappavaara, all four of which show very many and very interesting points of similarity. The third section, that of sulphuretted ores, is again open to doubt, and it seems as though more stress had been laid upon the accidental circumstance, whether a given deposit lies wholly within or merely in proximity to an igneous outburst with which it is probably genetically connected,

© 1901 Nature Publishing Group

than upon the real genetic and morphological relations of the deposit. Hence it is that Dr. Beck places the pyritic deposits of Rio Tinto, Mount Lyell, &c., in quite a different group from those of Sudbury, although most authorities prefer to group them together. Moreover, it is only in very few of the examples cited under this head that the magmatic origin of the deposit can be said to be in any degree probable.

The class of the stratified ore deposits is better defined, although it would have been preferable to have either excluded altogether deposits that consist of ores disseminated through an otherwise barren bed, or else to have included all forms of this mode of occurrence; the attempt to class impregnations amongst the epigenetic deposits, and to include in the present class only such disseminations as were formed contemporaneously with the bed in which they occur, is necessarily unsatisfactory, for there are very few instances in which the true mode of origin of such deposit has been proved beyond the possibility of dissent. Another source of weakness in this classification is the inclusion here of typically lenticular deposits, whenever the lens lies parallel to the stratification. Here again a relatively accidental character has been emphasised whilst the real geological relations of the deposit have been lost sight of.

Dr. Beck is perhaps at his best in his classification of veins, although the method here adopted is purely empirical. Such important geological relations as those of the vein to the country rock are utterly disregarded, contact veins are not distinguished from true fissure veins, &c., whilst the classification relies entirely upon the mineralogical character of the vein filling. This is the old Freiberg classification, revised and extended, and though it is less satisfactory when applied to the world as a whole than it was when restricted to the Freiberg district, it is nevertheless interesting, and, to a certain degree, even useful. By far the worst portion, and the only one that is wholly unsatisfactory, is the attempt to classify the gold-bearing veins, the distinctions here drawn being far too artificial, and the lines of demarcation too imaginary.

It may be noted, by the way, that the well-known Sheba deposit is here classed as a vein, whilst the bulk of what is known about it tends to show that it is certainly a bed. It is also doubtful whether the majority of the cinnabar deposits are really veins, as they are here designated.

In pointing out that many and grave faults can be found with Dr. Beck's classification of ore deposits, nothing more is intended to be conveyed than that Dr. Beck has not succeeded where every one else has failed. It may be doubted whether any one has yet evolved a classification of ore deposits that satisfied anybody—even its author; the inherent difficulties of the subject are so great and so manifold that a satisfactory solution of the problem may, in the present state of the science, fairly be declared to be impossible. Classification apart, Dr. Beck's work forms a contribution of the utmost value to the study of ore deposits; his descriptions are concise and clear, and his illustrations are well selected, especially as regards German, Austrian and Scandinavian deposits. The section on faults is eminently satisfactory, and indeed it would be hard to point to any work in which this complicated portion of the subject has received better treatment. It is difficult to pass judgment on half a book, but it may fairly be said that if the remainder of the work is only equal to the first half, it will constitute one of the best works available on the subject of ore deposits, provided that it is furnished with thoroughly complete indexes, and not with the apology for an index that usually does duty in German works. As the ore deposits described are arranged in accordance with the author's own system of classification, a complete alphabetical subject-index, together with a complete alphabetical index of geographical names, are needed to make Dr. Beck's work the highly useful book of reference that its other merits entitle it to become. H. LOUIS.

THE THEORY OF "SCREWS."

A Treatise on the Theory of Screws. By Sir Robert Stawell Ball, LL.D., F.R.S. Pp. xix + 544. (Cambridge University Press, 1900.)

SIR ROBERT BALL'S "Theory of Screws" is one of the most notable modern extensions of theoretical dynamics. It is based on Poinsot's discovery that every set of forces, regarded as acting on a rigid body, is reducible to a force along one definite line and a couple round the line; combined with Chasles's discovery that every instantaneous motion of a rigid body is reducible to rotation round one definite line and translation along it—in other words to a screwing motion. The modes of reduction in the two cases are strictly analogous; a force along a line being the analogue of a rotation round the line, and translation in any direction being the analogue of a couple whose axis has this direction.

The theory of screws treats of these two subjects in conjunction. The definite line along which the force acts, or round which the body rotates, is regarded as the *axis* of a *screw*, and the ratio of the couple to the force in the one case, or of the translation to the rotation in the other, is called the *pitch* of the screw. The sign of the pitch indicates whether the screw is right-handed or left-handed, and is not altered by reversing the screw end for end.

It would be convenient to have some general name for anything which follows the laws of combination employed in these reductions. Clifford called it a *motor*. It might well be called a *screw-actor*. The resultant of two screw-actors may be called their *sum*.

When the screw-actor is a set of forces, Sir R. Ball calls it a *wrench*—a name which is not suggestive of a statical concept, but rather of force combined with motion. The name *forcive* seems more appropriate.

When the actor is a screw motion, Sir R. Ball calls it a *twist*, and the name *twist-velocity* is given to a screw-velocity. The twists considered in the theory of screws are, in general, supposed to be so small as to admit of simple superposition, quantities of the second order being negligible.

Five numbers are required for specifying a screw. Two will give the direction of the axis, two the intersection of the axis with a fixed plane, and one the pitch. From another point of view a screw is defined by the five ratios of the six components of a screw-actor.

The theory of screws lends itself with special readiness to the discussion of the movements of a body with a given number of degrees of freedom. A body with one degree

© 1901 Nature Publishing Group